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WEEKLY EVENING MEETING,

Friday, May 28.

WILLIAM POLE, ESQ., M.A., F.R.S., Treasurer and Vice-President, in the Chair.

JOHN PERCY, M.D., F.R.S.,

LECTURER ON METALLURGY AT THE GOVERNMENT SCHOOL OF MINES, &c.

On the Modes of Extracting Gold from its Ores.

DR. PERCY began by stating that it was not his intention to touch upon any of those very interesting and important questions,—the distribution of Gold upon the earth's surface; the geological features of the regions which are believed to be indicative, not to say characteristic, of its presence; or the probable economical effect which the present unexampled supply may be expected to produce. To treat these subjects satisfactorily would require very much more time than that allotted to him on the present occasion. He should, therefore, direct special attention to certain points which he had reason to believe to be at the present time the most interesting.

After a brief review of the physical and chemical properties of gold, of special importance in the consideration of the subject, the Lecture was treated as follows: —

Modes of occurrence of Gold in nature. — Gold almost always occurs in nature in the metallic state; not pure, but alloyed with silver in various proportions and with the occasional addition of small quantities of iron and copper. A table* was presented, shewing the composition of native gold from various parts of the world. The presence of silver is constant with one or two rare exceptions; and its proportion varies not only in native gold from different auriferous districts, but even in specimens from the same locality. In Hungary gold is met with in combination with Tellurium. Native gold occurs crystallized and amorphous in small grains of greater or less size, in lamina, and sometimes in masses of the weight of many pounds.

Matters associated with native Gold.— These are various, such as quartz, either massive, or in a state of fine division as siliceous sand,—clay,—frequently certain kinds of iron pyrites,—rarely galena, &c. It seems doubtful whether in every instance the gold occurring in association with iron pyrites is wholly in the metallic state.— Spe-

[* The Members are referred, for many of the tables and diagrams illustrating this discourse, to Dr. Percy's Lecture, forming one of "The Lectures on Gold, delivered at the Museum of Practical Geology," published by Bogue, price 2*s.* 6*d.*]

cimens of gold were exhibited which had been extracted from pyrites from Wicklow in Ireland, Alston in Cumberland, and California. From historical records it would appear that gold has occasionally been found in different parts of the United Kingdom, but never in quantities to justify the slightest comparison with the recently discovered gold fields. In 1796, great excitement was caused by the discovery of gold in Wicklow, and about £10,000 worth of metal is said to have been obtained, but at a cost which did not cover the expences of extraction, notwithstanding that one lump was obtained weighing 22 ounces! It is very important, that at the present time, when so much excitement prevails respecting the newly explored gold regions, the public should not be misled by the notion that the extraction of gold will in every instance be profitable.

The extraction of Gold from auriferous sand or alluvium.—The method of washing by the bowl was described, and some different forms of bowl shewn. The principle of separating gold by washing depends upon its very high specific gravity as compared with that of the associated matter. The process carried on in the Ural was described in detail, and illustrated by diagrams. The average proportions of gold separated is little more than half an ounce to five tons. From 1819 in Siberia, and in the Altai from 1830 to the beginning of 1850, 774,920 lbs. (avoirdupois) of gold were obtained, of the value of about £46,495,200 sterling (Zerrener). The weight of matter removed by washing in the extraction of that amount of gold was (taking the average of half an ounce to five tons) 297,569,280,006 pounds, or 128,379,142 tons.

Stamping, washing, and amalgamation.—When gold is diffused through masses of quartz, as in the auriferous quartz veins of California, the mass must be reduced by stamps to a fine state of division. The product is washed in various ways; and the fine portions of gold, which might otherwise be carried away, are retained by mercury in an apparatus called the *amalgamation mill*. The method in practice at Schemnitz for this purpose was minutely described, and illustrated by diagrams, without which it would be difficult to render the processes intelligible.

Smelting of Gold ores, or the extraction of the metal in the furnace. The quartz must be reduced to a state of fine division and mixed with a substance which at a high temperature will combine with it and convert it into a fusible glass or slag. Such a substance is lime in certain proportions, or oxide of iron, or still better a mixture of the two. But as the gold exists only in very small proportion as compared with its matrix of quartz, it is necessary to introduce into the furnace lead, which may serve the purpose of dissolving and collecting the gold. By thus forming an alloy of gold and lead, and greatly increasing the bulk of the metal, which will subside to the bed of the furnace below the slag, the loss of gold will comparatively be prevented. In the event of employing oxide of iron as an agent to effect the fusion of the quartz, it would

obviously be desirable, when practicable, to obtain it by roasting with access of air on auriferous iron pyrites, such as the Californian.— The result of several experiments on the smelting of auriferous quartz were placed before the audience. The gold is separated from the lead by well known and ancient processes of cupellation. In the smelting of what is termed "Sweep," or the dust obtained by the sweeping of the shops of silversmiths and jewellers, the same principle is adopted. Lead is added, either in the metallic state, or in a state of combination, from which it may be evolved in the metallic state in the furnace, as in the case with certain lead slags. The part which mercury plays at the ordinary temperature in the amalgamation mills is performed by lead at a high temperature in the furnace. Anossow, a Russian engineer, is reported to have made successful experiments in the smelting of the gold-sand of the Ural by substituting cast iron for lead, and subsequently dissolving out the iron from the gold by sulphuric acid. He asserts that by this means he procured a very much larger quantity of gold than could have been separated by the most careful washing. His results, however, have not been received as correct. The results of experiments on the use of cast iron as a vehicle to collect the gold, were placed before the audience. By simply melting the cast iron in contact with lead, the greater part, if not the whole of the gold, appeared to be extracted from the iron with which it had been alloyed.

Although no positive opinion was expressed respecting the desirableness, or otherwise, of smelting the auriferous quartz of California, yet it was suggested, that in the event of the smelting process being adopted, it would, probably, for various reasons be found advantageous to smelt the quartz in conjunction with some of the South American silver ores, many of which contain gold.

The smelting of auriferous pyrites was next described. The pyrites is first roasted, by which process oxide of iron is formed. The roasted ore is smelted in a blast furnace with unroasted ore. A slag is obtained, and below sulphide of iron (or, as it is termed, a "*matte*,") containing the gold from the two portions of ore. This "*matte*" may be roasted, and again smelted with another portion of unroasted ore. A slag and "*matte*" are again obtained, and the latter will contain the gold from the three portions of ore. The gold may thus be concentrated, and ultimately extracted from the "*matte*" by smelting with lead. Many details were necessarily given which do not appear in this general notice of the lecture.

The treatment of certain auriferous ores by Chlorine.— Chlorine dissolved in water has been employed in extracting gold from a poor auriferous arsenical pyrites at Riechenstein. The ore is roasted, and the products treated with chlorine water. The gold is dissolved as chloride, and precipitated from its solution by sulphuretted hydrogen.

The sulphide of gold is converted into metal by the agency of heat alone.— A Council Medal was awarded for this process at the Great Exhibition of last year. In the first number of the Philosophical Magazine for 1848 will be found a series of experiments on this subject made by the Lecturer in 1847.

Melting of the Gold dust.—The gold obtained in grains (pepites) by washing, is melted in black lead crucibles with borax. The slag containing the foreign matter is skimmed off. A little corrosive sublimate is then, in particular cases, dropped in, after which the metal is cast into ingots. The use of corrosive sublimate is of ancient date. Some metallurgists believe its addition to be useless; but it is still occasionally employed by gold-melters of great experience.

Parting or separation of the Silver.— This is effected either by nitric or sulphuric acid. Gold must be alloyed with from $2\frac{1}{2}$ to 3 times its weight of silver to allow of the removal of the latter by the agency of either of those acids. The method of parting by nitric acid is well known. The process was briefly described. The silver dissolved out from the gold is now generally precipitated from its solution in nitric acid as chloride, by the addition of common salt. The chloride is washed and reduced to the metallic state by zinc.— Dr. Percy had intended to have given the results of careful experiments on the large scale, made by himself on the use of cast iron vessels in parting by sulphuric acid. The use of cast iron, for this purpose, was long ago proposed by a Frenchman at Marseilles. In the experiments just referred to, several thousands of ounces of silver were operated on. No description has yet been published, so far as he is aware, giving all the practical details necessary to the successful application of iron vessels for parting. The shortness of the time prevented the fulfilment of the intention abovementioned.

"In conclusion," said Dr. Percy, "permit me to offer a few observations in connection with the subject which I have ventured to submit to the Members of the Royal Institution. That subject is essentially what is termed *practical*. Yet in every process which we have examined, the principles of science are involved. The metallurgic arts present a varied and beautiful field for investigation, and merit greater attention from chemists than they have yet received, at least in this country. The reactions which take place in many metallurgical operations require for their elucidation the highest science, and have only to be known to be duly appreciated. This evening I may speak freely of the attractions of metallurgy to the chemist, who is intent upon the investigation of the glorious truths of science for their own sake; but if I had to address Manufacturers upon the advantage of the applications of science to metallurgy I should be under the necessity of employing the only argument which will avail with them,— that of direct and positive advantage.

"We have seen, that although Gold may be present only in very

small quantity, it may yet by skilful manipulation be extracted with advantage; and in these days of gold-mining adventure, it is to be feared, that many may be led by this consideration to believe that wherever gold is found, there is a favourable field for mining enterprize. But it must not be forgotten, that it is not merely a question of the *occurrence of gold* in any given district, but whether it is present in sufficient quantity to admit of profitable extraction. If it were necessary,— as I am credibly informed it would be in one locality,— to expend a sovereign in order to extract sixteen shillings' worth of gold, dividends would be expected in vain.

"The consumption of gold in the *Arts* is an interesting subject of inquiry. A very large amount of that which is thus applied is irrecoverably lost,— as, for instance, the gold employed for gilding with gold leaf, and that used in ornamenting china. Some idea of the extent of this loss may be formed, from the fact that one gold-beater will consume many thousand pounds' worth of gold annually, and there is one manufacturer of china who consumes annually not less than £2000 worth of gold. There is also a large consumption of gold in what is called the gilt-toy manufacture. It seems probable that if the metal should become much more abundant, its applications in the Arts would be proportionately extended.

"Gold after all does not constitute the true riches of a nation. On account of its hitherto comparatively rare occurrence and gradual supply, it has been well selected as the conventional representative of wealth. It is a very beautiful metal and is well adapted to the various purposes of ornament to which it is applied; but in respect to *intrinsic* excellence it will not compare with *iron*. A golden needle would be a poor substitute for one of polished steel, and no ordinary skill would be required to operate upon a tender joint with a golden knife. Iron-stone and coal, with conditions favourable to their being worked, are more to be desired than the treasures of an El Dorado; and probably the most important, though distant result of the discovery of gold in California and Australia, will be that of developing the natural resources of those great countries, by attracting the tide of emigration to their shores."

[J. P.]

In the Library were exhibited: —

Four Specimens of Gold in Quartz from Ballard Diggins, near Port Philip, Australia. [Exhibited by R. Brooks, Esq.]

Baillie's Patent Volute Springs, with Model of Railway Carriage. [Exhibited by Mr. Howard.]

Specimens of Silicious Conglomerate from Hertfordshire, and of Krokidolite. [Exhibited by Mr. Tennant.]

Manufactures in Imitation-Ivory and Protean Stone, by Mr. Cheverton.

A Collection of Shells arranged for the Study of Conchology; and Specimens of Cinnamic Acid and Tantalite. [Exhibited by T. N. R. Morson, Esq., M.R.I.]

Illustrations of Endosmosis, from Royal Institution Laboratory.

Design for the Chemical Society's Seal, by J. Bonomi, Esq. and Impressions from the Seal, engraved by Mr. G. Barclay.

Map of Gold Country, Bathurst, Australia. [Exhibited by Mr. Lloyd.]

Model of "the Martyrs' Memorial," Oxford, by Mr. Flack.

Portrait of a Lady, painted in Pastel on Vellum, by Alexander Blaikley, Esq.

Portraits of Sir James Duke, Dr. Chambers, and Mrs. Blake, by J. Z. Bell, Esq.

Three Caps made of Needlework, worn by the Mopilas, or Muhammedans of the Malabar Coast; Chinese Painting on Glass; Specimen of Tea prepared for the use of the Emperor of China; the Jooce or Talisman of good Omen placed by the Chinese in their chief apartments; Chinese Lady's Shoe and Metallic Mirror. Various Articles of Burmese Costume. Maliva and Kandeish Opium and the Opium Pipe of the Chinese. [Exhibited by the Royal Asiatic Society.]

WEEKLY EVENING MEETING,

Friday, June 4.

Sir Charles Fellows, Vice-President, in the Chair.

John Scott Russell, Esq., F.R.S.

On English Ships and American Clippers. (Second Notice.)

Mr. Scott Russell commenced his discourse with the following remarks:

"When I had the pleasure a month or two ago of stating a few facts, and hazarding some opinions, regarding the present state of knowledge, and the actual progress of practice in the construction of ships, I confined my remarks, which were necessarily few and imperfect, to American Ships and Yachts, comparing them especially with our own. I selected the Americans, because I believed them to be more advanced in the Arts of Navigation and Naval Construction than any other nation; and because it may be regretted that they are so, inasmuch as *we* were not long ago in the place they now occupy: and secondly, because I believed it to be entirely owing to our own adherence to prejudices, and to an antiquated system established by bad legislative enactments, that we have been left behind, with larger